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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G08C 21/00, G09B 11/00

A1

(11) International Publication Number: WO 98/32107

(43) International Publication Date: 23 July 1998 (23.07.98)

(21) International Application Number: PCT/US98/01210

(22) International Filing Date: 21 January 1998 (21.01.98)

(30) Priority Data:
08/786,610 21 January 1997 (21.01.97) US

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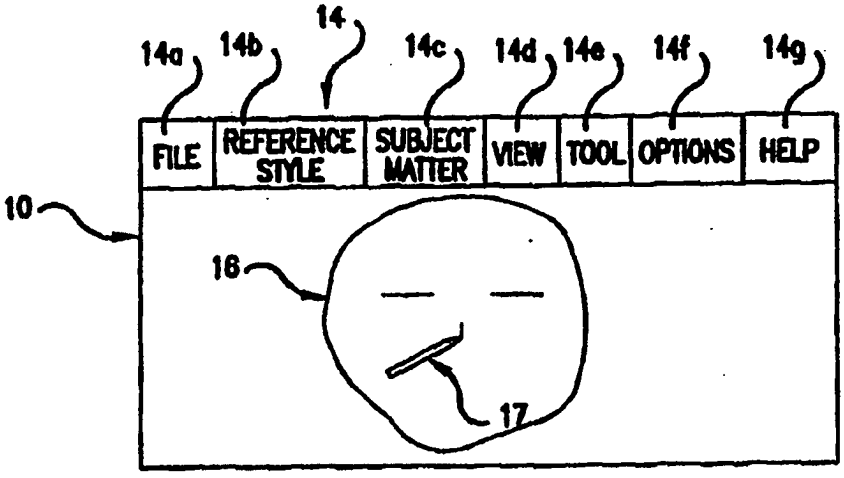
(81) Designated States: AL, AM, AU, AZ, BA, BB, BG, BR, BY, CA, CN, CU, CZ, EE, GE, GH, GW, HU, ID, IL, IS, JP, KG, KP, KR, KZ, LC, LK, LR, LT, LV, MD, MG, MK, MN, MX, NO, NZ, PL, RO, RU, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UZ, VN, YU, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD OF AND APPARATUS FOR TEACHING DRAWING, PENMANSHIP, AND HAND–EYE–MEMORY COORDINATION



(57) Abstract

Educational software (14) is disclosed that is capable of executing on a conventional computer system. The software develops the drawing and/or penmanship skills and improves the hand–eye–memory coordination of a student–user. The student–user of the software selects a reference style (14b) and subject matter (14c) for a reference figure. After selection, an image of the reference figure is displayed (16) on the screen of a monitor. The student–user studies the image of the reference figure and then attempts to trace that figure. A variety of conventional input devices (17) may be utilized by the student–user to attempt the trace of the reference figure, including a touch–sensitive screen on the monitor (10). Upon beginning the attempted trace, a preselected portion of the image of the reference figure is blanked from the display. The student–user may continue the attempted trace of the reference figure, forming a trace figure. An image of the trace figure is displayed on the monitor of the screen as the student–user amends that figure. After the student–user finishes amending the trace figure, the reference figure is redisplayed on the screen of the monitor to allow the student–user to compare the two figures.

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METHOD OF AND APPARATUS FOR TEACHING DRAWING, PENMANSHIP, AND HAND-EYE-MEMORY COORDINATION

FIELD OF THE INVENTION

The invention relates generally to educational software, and, more particularly, to educational software used to develop the drawing and penmanship skills and to improve the hand-eye-memory coordination of a student. The invention further relates to methods for developing such drawing skills and for improving such coordination.

BACKGROUND OF THE INVENTION

The related art includes computer-based graphics application software that allows a computer user to draw figures and to view images of those figures as they are visually displayed on a screen of a monitor or similar output device. Examples of the related art software are the DrawPerfect® software of WordPerfect Corporation, AutoCAD® software of Autodesk, Inc. and Microsoft® Windows Paint of Microsoft Corporation. Other related art software does exist.

Using the typical related art software, the user may draw a figure by choosing a drawing tool and by utilizing the drawing tool to create a series of readily viewable graphic images on the screen of a computer monitor. However, under the related art software, the user may not retrieve a figure stored as a bit map data file on the memory unit of the computer and then attempt to trace that figure using the computer drawing techniques well known in the related art. Therefore, although the related art software is quite effective for its limited applications, the related art software does not compare with the benefits achieved through use of the present invention.

SUMMARY OF THE INVENTION

The present invention is a method and apparatus for developing the drawing and penmanship skills of a student.

The present invention further is a method and apparatus for improving the hand-eye-memory coordination of the student.

The claimed method, in some of its broader aspects, comprises the steps of displaying a reference figure, displaying a trace figure as it is created by the student, clearing a part or all of the reference figure once the student begins to create the trace figure and subsequently redisplaying the reference figure to compare it with the trace figure.

In a computer-implemented embodiment of the invention, the claimed method comprises the steps of displaying an image of a reference figure on a screen of a monitor, displaying an image of a trace figure on the screen of the monitor as the trace figure is being created by the student-user, blanking out at least a portion of the displayed image of the reference figure within a predetermined time after the student-user begins to create the trace figure and subsequently redisplaying the image of the reference figure on the screen of the monitor to permit a comparison between the reference figure and the trace figure.

The computer system preferably includes a monitor that may produce an image of the figures so that they are readily viewable by the student-user. In a preferred embodiment, the monitor allows through-the-screen data input entry. Under these circumstances, the monitor may serve as both an input device and an output device of the computer system used to carry out the invention. In this preferred embodiment, the monitor may even include a touch-sensitive screen that would allow the student-user to use a writing instrument or the like to create the trace figure.

A BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, features and advantages of the invention will be more readily apparent from the following detailed description of the invention in which:

Figures 1A-C depict the visual display of the monitor viewable by the student-user during execution of each respective mode of the application software of the invention;

Figure 2 is an illustrative block diagram of the hardware components of a computer system and its associated input/output peripheral devices which may be used to carry out the invention; and

Figures 3A-C are an illustrative flowchart of application software for controlling the computer system of Fig. 2 which may be used to carry out the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figs. 1A-1C depict the screen of a monitor 10 of a computer system. In a preferred embodiment, monitor 10 includes a touch-sensitive screen, as later described with reference to Fig. 2.

Fig. 1A specifically shows an example of the image of a reference figure 12 displayed by the screen of monitor 10 for view by a student-user when the invention has completed its setup mode. The program steps performed during each execution mode will be later described in greater detail throughout the discussion referring to the software flowchart drawings of Figs. 3A-C. However, those skilled in the art will appreciate that the invention is described as having distinct execution modes merely to facilitate the description of the invention. Thus, the modes are described for illustrative purposes only and should not be construed to restrict the scope of the claims appended to this disclosure.

The student-user initiates use of the invention by choosing a desired reference style and subject matter for reference figure 12. Those skilled in the art will appreciate that, under conventional computer technology, the student-user may select the reference style and subject matter by entering data with a variety of input peripheral devices. Nevertheless, to illustrate an example of this procedure, the student-user may drag a mouse pointer to a drop-down menu bar of the type well known in the art, such as

menu bar 14 shown in Figs. 1A-1C, and make the selection of the desired reference style and subject matter with the click selection technique generally known among ordinary users of computer hardware and software technology.

Drop-down menu bar 14 includes several drop-down menus. Illustratively, these include file menu 14a, reference style menu 14b, subject matter menu 14c, view menu 14d, tool menu 14e, options menu 14f, and help menu 14g. File menu 14a preferably includes the retrieve, print, and save requests described below. Reference style menu 14b includes the reference style selections of reference figure 12, including any sub-menus, if applicable. For example, upon opening menu 14b, the student-user may select from an open-ended list of reference style selections, including "Architects", "Cartoonists", and "Artists". The list of reference style selections may include sub-menus to allow the student-user to select an even more specific reference style selection. For example, the "Artists" selection may include sub-menus such as "Rembrandt", "Goya", "Picasso", etc. This hierarchical scheme for selecting the reference style of reference figure 12 is well known in the art.

Subject matter menu 14c includes the subject matter selections of reference figure 12, including any sub-menus, if applicable. For example, upon opening menu 14c, the student-user selects from an open-ended list of reference subjects, including "Hands", "Faces", "Houses", "Clouds", "Trees", "Machines", "Letters", and "Numerals". The list of reference subjects may include sub-menus to allow the student-user to select an even more specific subject matter selection. For example, the "Faces" selection may include sub-menus that allow the student-user to specify "Mouth" or "Eyes" selections. Of particular interest, the subject matter may also include alphabets, Kanji, Hiragana, Katakana, numerals and the like so as to provide an opportunity to practice penmanship skills.

View menu 14d preferably includes the translate and change size requests, later described. Tool menu 14e

includes an open-ended list of drawing tools that the student-user may utilize to create trace figure 16. Options menu 14f preferably includes optional features such as Quick Sketch enable and soundback enable, described below. Help menu 14g includes a help tutorial file to provide tips for the operation of the software and for the creation of trace figure 16.

After the student-user selects the reference style and subject matter of reference figure 12, the appropriate bit map data file corresponding to the selected reference figure is retrieved from the memory unit of the computer. An image of the reference figure 12 is then visually displayed on the screen of monitor 10, thereby allowing the student-user to study the reference figure before the student attempts to trace that figure.

When the student-user initiates a trace of reference figure 12, a selected portion of the image of the reference figure is cleared from the monitor so that the student-user can no longer view it. In its preferred form, the entire reference figure is removed from the view of the student-user when the student-user begins to trace the reference figure.

Fig. 1B depicts an example of the display screen of monitor 10 during the trace mode of the invention while the user creates an image of a trace figure 16 using a drawing device such as a light pen 17. As noted above, the modes of operation for the invention, including the trace mode, are described for illustrative purposes only and therefore they should not be construed to limit the scope of the invention. Fig. 1B shows the invention in the above-described preferred embodiment wherein the entire image of reference figure 12 is cleared from display on the screen of monitor 10 during the attempted trace of that reference figure by the student-user.

Fig. 1C depicts the screen of monitor 10 during the assessment mode of the present invention. While the software is in its assessment mode, the screen of monitor 10 displays both reference figure 12 and trace figure 16. In a preferred embodiment of the invention, an image of reference figure 12

is displayed in a manner that allows the student-user to readily distinguish it from trace figure 16. For example, reference figure 12 may consist of dashed lines instead of straight, elongated lines, as shown in Fig. 1C. This manner for distinguishing the figures is shown in Fig. 1C for illustrative purposes only. Thus, it is to be appreciated that reference figure 12 may also be shown in a different color than trace figure 16 or in any other similar manner known in the art wherein reference figure 12 may be distinguished from trace figure 16. It should further be appreciated that trace figure 16 may be altered from its standard form to permit the student-user to readily distinguish the two figures, although that arrangement is not the illustrated embodiment of the invention.

During its assessment mode shown in Fig. 1C, the software calculates an assessment score. The assessment score indicates to the student-user the accuracy of the completed trace figure 16 compared with reference figure 12. Thus, during its assessment mode, the software of the invention compares trace figure 16 with reference figure 12. The student-user may then execute additional features of the invention while in the assessment mode. All of these features of the invention are described in greater detail below with reference to the flowchart drawings of Fig. 3. Once the student-user exits the assessment mode, the student-user may re-execute a run of the software programs and attempt to create a new trace figure of the reference figure, if desired. Alternatively, the student-user may create a trace figure of a new reference figure. The student-user may also exit the software to perform standard computer operational tasks, such as file transfers, for example.

Referring to Fig. 2, an example of a computer hardware system and its associated input/output peripheral devices that are capable of carrying out the invention are shown. In particular, Fig. 2 shows a computer system 18 and a plurality of input/output peripheral devices 20. As shown, the hardware devices of computer system 18 include a central

processing unit 22, a graphics card 23, a random access memory unit 24, a read-only memory unit 26 and a plurality of input/output ports 28. It is to be appreciated that computer system 18 may be powered by conventional computer energy sources.

Central processing unit 22 directs operation of and communication with all devices that comprise computer system 18. Central processing unit 22 determines the steps of execution for all software executed on computer system 18, including the application software illustrated in flowchart form as Fig. 3. Central processing unit 22 further retrieves data from the memory units of computer system 18 and stores data to those memory units before and after the processing steps executed by the invention.

To perform its functions, central processing unit 22 includes a control unit and an arithmetic/logic unit, both of which are not shown in Fig. 2. The control unit, as its name implies, controls the activity and operation of central processing unit 22. The arithmetic/logic unit, on the other hand, manipulates data by performing arithmetic and logical operations, as necessary.

Graphics card 23 may be conventional like those well known in the art. The graphics card 23 is a circuit board installed in central processing unit 22 that processes bit map data files and generates images to display on the screen of monitor 10.

Random access memory unit 24 is used to store the files comprising the application software and its associated data files, including the bit map data files corresponding to reference figure 12. Central processing unit 22 retrieves these files from secondary storage devices, such as off-line disk storage device 29 or on-line disk storage device 30, and temporarily stores those files in random access memory unit 24 for processing while it carries out the invention.

As is conventional in the art, read-only memory unit 26 is used to store system software programs that control computer system 18, such as operating system files. Read-

only memory unit 26 is also used to perform status checks for the hardware devices of computer system 18. In a preferred embodiment, read-only memory unit 26 may comprise an erasable programmable read-only memory chip (not shown). In this preferred form, the system software files are not only programmable, but are also erasable in the manner well known in the art.

Input/output ports 28 establish an interface between the plurality of peripheral devices 20 and the central processing unit 22 of computer system 18. The input/output ports 28 allow the central processing unit 22 to communicate with and control the input/output peripheral devices 20 of computer system 18. The above description of all hardware components of computer system 18 is well known in the relevant art and, therefore, no further discussion is necessary to enable those skilled in the art to make and use the invention.

As indicated above, a plurality of input/output peripheral devices 20 are interfaced with central processing unit 22 through input/output ports 28. The peripheral devices 20 shown in Fig. 2 are illustrated for exemplary purposes only. Those skilled in the art will appreciate that other input/output peripheral devices could be used to carry out the present invention as efficiently as well.

Included among the input peripheral devices shown in Fig. 2 are a light pen 31, drawing pad 32, mouse 33, joystick 34, and keyboard 36. Light pen 31 will be described later with reference to one technique of through-the-screen input entry with monitor 10.

Drawing pads, such as drawing pad 32 shown in Fig. 2, are well known in the art and are particularly useful as input devices for computer graphics software application programs such as those found in the related art. Drawing pad 32 may be utilized by the student-user while creating trace figure 16 (see Fig. 1) during the trace mode of the invention, although it may also be used to enter other data for processing by central processing unit 22, such as the

reference style and subject matter selections of reference figure 12 (see Fig. 1), for example.

Computer mice, such as mouse 33 shown in Fig. 2, are well known in the art and are useful for entering data during execution of the application software programs currently available. Mouse 33 may be used to create trace figure 16 (see Fig. 1), for example. Mouse 33 may also be used to enter additional data for the invention such as the student-user selections of reference style and subject matter of reference figure 12 (see Fig. 1), among other things.

Joystick 34 is also conventional in the art and may be used as an input device to help the student-user create trace figure 16 (see Fig. 1) during the trace mode of the invention. Joystick 34 may also be used for other data entry functions, as desired.

Keyboard 36 is a conventional input device utilized in practically all modern computer systems such as that depicted as reference numeral 18. Keyboard 36 may be used for several of the data entry functions of the present invention, such as the selection of the reference style and subject matter of reference figure 12 (see Fig. 1) during the setup mode of the invention. Keyboard 36 may also be used for data entry to help the student-user create trace figure 16 (see Fig. 1) during the trace mode of the invention.

Included among the output devices of the present invention are a printer 38 and monitor 10. Printers, such as printer 38 depicted in Fig. 2, are well known in the art and are typically used by computer systems to produce hard copy document outputs. In a preferred embodiment, printer 38 may comprise the laser printer technology well known in the art so that letter-quality documents are produced by the printer. Printer 38 may be used with the present invention to produce a variety of hard copy document outputs while carrying out the invention, including, but not limited to, hard copy documents showing images of reference figure 12, trace figure 16 and the contents stored in a tutorial help file.

Monitors, such as monitor 10 shown in Fig. 2, are also well known in the art and are typically used to visually display images produced by computer software applications. Nearly all personal computer systems, such as computer system 18, include a monitor. In its preferred form, monitor 10 permits through-the-screen input entry. A first example of through-the-screen input entry can be accomplished through use of a light pen, such as light pen 31 shown in Fig. 2. In operation, the computer displays a brightly lit spot on the screen of monitor 10. The student-user touches light pen 31 to the spot of light. Through use of light pen 31, the student-user may then draw images on the screen of monitor 10 for direct computer processing. The computer preferably does not automatically smooth the drawn images so that the true trace figure 16 is displayed on the screen of monitor 10.

Another preferable through-the-screen input technique uses a touch-sensitive screen. Under this technique, the student-user simply touches the screen of monitor 10 at various parts of that screen, depending on the desired data entry. When monitor 10 includes a touch-sensitive screen, the student-user may, if so desired, create and visually display trace figure 16 during the trace mode of the invention by touching the screen with a writing instrument or related item such as his/her finger during the attempted trace of reference figure 12. Furthermore, the student-user may enter other data to be processed by central processing unit 22, such as the selection of reference style and subject matter of the desired reference figure 12, for example.

It should be appreciated that the through-the-screen input techniques described in the preceding paragraphs permit monitor 10 to function as both an input device for entry of data and an output device for visual display of images created by the application software.

Remote access unit 42 is an additional dual input/output device shown in Fig. 2. Remote access units, such as remote access unit 42 shown in Fig. 2, are well known in the art. Remote access unit 42 preferably allows central processing

unit 22 of computer system 18 to communicate with external computer systems over local networks and internet channels, for example. Remote access unit 42 may include a modulation/demodulation device, such as a modem of the type well known in the art (not shown). Remote access unit 42 permits computer system 18 to retrieve data files pertinent to the present invention. For example, by utilizing remote access unit 42, the student-user could retrieve bit map data files stored on external computer systems. These bit map data files may, in the ideal situation, correspond to additional reference figures not stored within the memory units of computer system 18. Furthermore, the application software of the invention may be supplied by a remote computer system or server through the remote access unit 42 in the manner well known in the art.

Figs. 3A-C are an illustrative flowchart of application software that may be used to carry out the invention. As will be described with reference to Fig. 3C, the student-user, upon completion of trace figure 16, may re-create a trace figure of reference figure 12, or, alternatively, the student-user may create a trace figure for a different reference figure. If the student-user opts to do either, the software recycles as schematically represented by complementary connectors 44a(Fig. 3A) and 44b(Fig. 3C) so that the software may be re-executed by computer system 18.

Fig. 3A is a flowchart for those parts of the software preferably executed during the setup mode of the invention. As previously indicated, the execution modes of the invention are set forth merely to facilitate the description of the invention. Accordingly, the description of execution modes for the software should not limit the scope of the appended claims.

Block 46 depicts the starting point for an execution run of the application software. During the setup mode, the student user selects a reference style and subject matter, adjusts the size and location of the figure to be traced and selects a drawing tool and options. Thus, after starting the

execution of the application software, the program tests for and subsequently accepts a user reference-style selection input, as depicted by blocks 48 and 50. As previously described, the student-user selects the reference style of reference figure 12 by entering data with a variety of peripheral input devices, such as several of the peripheral devices 20 (see Fig. 2). To select the reference style of reference figure 12 with the illustrated embodiment, the student-user opens reference style menu 14b (see Fig. 1).

After accepting the desired reference style selection, the application software tests for and subsequently accepts the subject matter for reference figure 12 selected by the student-user. Blocks 52 and 54 depict the testing and acceptance steps for the subject matter of reference figure 12. To select the subject matter of reference figure 12 with the illustrated embodiment, the student-user opens subject matter menu 14c (see Fig. 1). Similar to the selection of reference style, the student-user selects the subject matter of reference figure 12 by entering data with a variety of input peripheral devices, such as several of the peripheral devices 20 (see Fig. 2).

After accepting the subject matter of reference figure 12 selected by the student-user, the application software retrieves a bit map file stored within the memory units of computer system 18. The system then processes the bit map file to prepare an image of reference figure 12 for display on the screen of monitor 10. The bit map file retrieved by central processing unit 22 corresponds to a reference figure having the reference style and subject matter parameters selected by the student-user. The retrieval of the bit map file is indicated in the flowchart by processing block 56. Upon retrieving the bit map file for reference figure 12, the application software displays an image of reference figure 12 on the screen of monitor 10. This operation is shown by input/output block 58 of the flowchart diagram. The student-user is then able to study the image of reference figure 12 before creating a trace figure 16 of that reference figure.

The student-user can then modify reference figure 12 by use of the view menu 14d. If the student-user enters data to translate or change the size of reference figure 12, the software operates to translate or change the size of reference figure 12 as represented by decision block 60 and process block 62. As an example, the reference figure 12 may be translated along a horizontal or vertical axis or it may be rotated through an angle of 90°, 180°, or 270° from its initial display position.

The student-user then selects the drawing tool used to create trace figure 16 by opening tool menu 14e (see Fig. 1). The operation of the software to select the drawing tool is represented by decision block 64 and process block 66. Upon opening menu 14e, the student-user selects the desired drawing tool from an open-ended list of drawing tools, including "Stylus", "Brush", "Pencil", "Palette Knife", and "Eraser", for example. It should be apparent from this open-ended list of drawing tools that the student-user may select from drawing tools that allow the tracing of fine lines to more artistic simulated paintbrush or airbrush strokes. The student-user may also select or change the color of the image to be displayed on the screen of monitor 10 during amendment of trace figure 16 (see Fig. 1). Further, the student-user may set the drawing tool to permit shading within enclosed geometric shapes. It should be apparent from the exemplary list of drawing tools that the student-user may enable erasures while practicing the invention. This described scheme used to change the drawing tool and color of the images produced by use of that drawing tool are well known in the art.

The student-user then selects which optional features he wants to use by opening option menu 14f. The operation of the software to select these options is represented by decision block 68 and process block 70. Upon opening menu 14f, the student-user selects from among options such as Quick Sketch and soundback whose functions are described below.

After processing the option menu, the software exits its setup mode and enters its trace mode. This is schematically depicted by connector 55A, shown in Fig. 3A, and its complementary connector 55B, shown in Fig. 3B. In a preferred embodiment, the software displays instructions on the screen of monitor 10 (see Fig. 1) to indicate that the student-user may begin to trace the reference figure when ready. For instance, the phrase "Trace what you see by touching your 'Drawing Tool' to the screen" may be displayed in conjunction with the display of reference figure 12. Obviously, this phrase would be appropriate if monitor 10 included a touch-sensitive screen. If such instructions are displayed on the screen, the instructions preferably will be removed once the student-user begins to create trace figure 16 (see Fig. 1).

Fig. 3B is a flowchart of the software that carries out the trace mode of the invention. Throughout the trace mode, the software continually accepts user-entered data, generally referred to as user input. The software evaluates the entry, provides feedback such as a display or an audio signal, if selected, and stores the entry. The user input is accepted until the software exits from its trace mode and enters its assessment mode. Those skilled in the art will appreciate that the user inputs represented as decision blocks in Fig. 3B are shown for illustrative purposes only. Changes and modifications may be made to the available user inputs without departing from the spirit and scope of the invention.

Entry into the trace mode can be automatic or manual. For example, a default timer can be started upon selection of the subject matter which will cause automatic entry into the trace mode after allowing sufficient time for selection of tools and options on menus 14e and 14f. Alternatively, entry can be manually controlled by making "entry" a menu selection on one or more of the menus 14d, 14e, and 14f.

Upon entry into the trace mode, the software continuously tests for a user input as indicated at block 80 of Fig. 3B while continuing to display the reference figure.

Upon detecting a user entry, the software blanks the screen as indicated at block 82. Alternatively, the software might blank only a portion of the screen, for example, the portion where the user is working. In some applications as where the emphasis is on eye-hand coordination in rapidly making a meticulous copy of a complicated reference figure, it may be advantageous not to blank the screen at all. Preferably, the degree of blanking is controlled by menu bar 14 and, in particular, the selection of an appropriate option by option menu 14f.

At block 84, the software tests if the user has selected the Quick Sketch option. This option provides a timing clock which the user must beat in completing his entry. The amount of time can be selected by the user or generated by the software as a function of the complexity of the reference figure. If the option is selected, the timer is started as indicated at block 86. The software then process and scores the entry as represented by block 88.

Many well known methods may be used to process the trace entry, compare the trace entry with the reference figure, and subsequently calculate a score of the trace entry. The following discussion is an illustrative embodiment of carrying-out the method steps represented by block 88. First, the computer processes the entry by computing the edges of the trace figure entry. The computer performs this step, for example, by segmenting the trace entry data at discontinuity areas or sharp changes in the trace entry data pattern, and subsequently fitting surfaces to these line segments. Well known surface fitting methods include least-squares norms, polynomial fitting, and spline fitting algorithms. The computer may then assess the trace entry vis a vis a corresponding portion of the reference figure by comparing a least means squared fit for the surface edge computed for the trace entry with that of the corresponding portion of the reference figure. This assessment could be accomplished by calculating the area between the least means squared fit of each surface of the reference figure with that

of the trace figure. Alternatively, for discrete trace entry data, the computer could calculate the straight line distance between the discrete element of the reference figure with that of the trace figure in order to score the entry.

In the preferred embodiment, a weighting scheme is implemented to compute a weighted score for the trace entries. Different weighting schemes may be used dependent upon the complexity of the portion of the reference figure being traced or the difficulty level of the subject matter being traced. For example, a slight discrepancy between a trace entry and the reference figure may be weighted heavily when the student user is practicing handwriting, while a similar discrepancy when the student is attempting to trace an Impressionist painting may be given little weight.

In the preferred embodiment of the invention, the system includes a soundback feature which provides an audible cue as to the accuracy of the entry. Thus, after scoring the entry, the software tests at block 90 if the soundback feature has been selected. If it has, the software then tests if the score for the entry exceeds a threshold. This threshold may be a value set by the user at the time the soundback option is selected or it may be a default value specified by the software as a function of the complexity of the reference figure. If the score exceeds the threshold, an audible feedback is generated as indicated by block 94. Advantageously, a parameter of the audible signal such as frequency or magnitude may vary as a function of the magnitude of the score or of the difference between the score and the threshold. In the preferred embodiment, the user is then provided an opportunity to correct the entry as the software returns immediately to block 88 where it receives and scores the entry. In this way the user can rely on changes in the audible magnitude or pitch to guide him in the entry of the trace figure.

If the score does not exceed the threshold or if the soundback feature was not selected, the software then stores the input and the score and adds the new entry to the display

of the trace figure that has already been generated. This is represented by box 96 in Fig. 3B.

The software then checks at box 98 if the timer has expired. If the Quick Sketch feature was not selected, the timer was never started and time out will never happen. If, however, Quick Sketch was selected and the timer has expired, the software will exit from the trace mode and enter the assessment mode as represented schematically by connectors 104 of Fig. 3B and 106 of Fig. 3C.

If the timer has not expired, the software tests at block 100 whether the user has terminated the trace mode. Preferably, user control of termination is provided for at one or more positions in the menu. For example, "exit trace mode" may be one of the menu selections on file menu 14a or an exit button may be located in one or both of the upper corners of the display screen as on many graphical user interfaces. If the user has terminated the trace mode, the software exits the trace mode in the same fashion as when the timer expires.

If termination has not been selected, the software tests at block 102 for a new entry. If there is none, it cycles back to decision block 98 and continues to loop until the trace mode is terminated or there is a new entry. If there is a new entry, the software returns to block 88 to receive and score the entry.

Fig. 3C shows a flowchart of software that carries out the assessment mode of the invention. Once the software has exited its trace mode, the entire reference figure 12 is redisplayed on monitor 10 so that the student-user may readily observe the accuracy with which he/she created trace figure 16. This operation is shown by input/output block 110. The software then calculates the accuracy assessment score as indicated at block 112. To do this, the software sums the individual scores computed during entry of the trace figure. After the accuracy assessment score has been calculated, the software displays the accuracy assessment

score on the screen of monitor 10. This operation is depicted by input/output block 114.

It will be appreciated that other means may be used for comparing the reference figure with the trace figure and for informing the user of the results of this comparison both while the trace figure is being drawn and after the trace is complete.

After displaying the assessment score, the software then preferably asks the student-user whether he/she would like to print or save any part of the session. Specifically, as indicated at decision block 116, the software tests if the user wants to save the reference figure 12, the trace figure 16, or the assessment score. If any of these items are selected, they are saved or printed as represented by process block 118.

The software then asks the student-user whether he/she wishes to continue with an additional trace as shown by decision block 120. If so, the software then returns to the input mode as represented by complementary connectors 44b and 44a(Fig. 1). If, however, the student-user does not wish to continue execution of the software by creating another trace, the software ends its execution as depicted by end terminal 122.

Those skilled in the art will appreciate that the invention develops the drawing and penmanship skills and improves the hand-eye-memory coordination of the student-user in a manner entirely different than any way heretofore practiced under the related art.

Although the invention has been described with reference to a single embodiment (with, however, several preferred features of that embodiment), it will be apparent to those skilled in the art that changes and modifications may be made while practicing the invention. For example, while the reference figure is described as being a bit-map data element, those of ordinary skill will recognize that other well known types of graphic images may also be implemented such as vector-based images. Other techniques may also be

used for comparing the reference figure with the trace figure and for informing the user of the results of the comparison. Further, while the invention has been disclosed as student-initiated, those of ordinary skill will recognize that a computer may initiate and select several of the menu selections and options disclosed. For example, the computer may select the reference matter, subject matter, and drawing tool to be used. Further, the computer may initiate an entire run of the software so as to display a reference figure, attempt a trace of the reference figure, and display an assessment score. In this way, the computer demonstrates to a student-user how the application operates.

Numerous variations may also be practiced in the interaction between the user and the computer. For example, rather than blank out the reference figure throughout the time that the trace figure is being drawn, as in the preferred embodiment depicted in Fig. 3B, it may be advantageous to restore the display of the reference figure after entry of each portion of the trace figure is completed and then blank out the reference figure again when the user starts to draw the next portion of the figure. In addition, upon the completion of each portion of the trace figure, the display can highlight the next portion of the reference figure that should be drawn, for example, by intensifying the color of that portion of the display or causing the display to flash on or off. This may prove particularly useful in teaching the user to execute a series of pen or brush strokes in a specific order as is used, for example, in the writing of Kanji characters.

While numerous variations in the invention may be made, it will also be apparent to those skilled in the art that, even if these and other changes and modifications were made, they would not depart from the spirit and scope of the invention.

What is Claimed Is:

1. A method for developing drawing and/or penmanship skills of a student, comprising the steps of:

(a) displaying a reference figure;

(b) displaying a trace figure as said trace figure is being created by said student;

(c) blanking out at least a portion of said displayed reference figure within a predetermined time after said student begins to create said trace figure; and

(d) comparing said reference figure with said trace figure.

2. The method of claim 1 wherein said student may select said reference figure from a plurality of available reference figures.

3. The method of claim 1 wherein the steps of the method are performed with a computer system.

4. The method of claim 1 wherein the comparing step further comprises the step of generating a score indicative of the comparison between said reference figure and said trace figure.

5. The method of claim 1 wherein the comparing step further comprises the step of generating an audible signal indicative of the comparison between said reference figure and said trace figure.

6. A computer-implemented method for developing drawing and/or penmanship skills of a student-user, comprising the steps of:

(a) displaying an image of a reference figure on a screen of a monitor;

(b) displaying an image of a trace figure on said screen of said monitor as said trace figure is being created by said student-user;

(c) blanking out at least a portion of said displayed image of said reference figure within a predetermined time after said student-user begins to create said trace figure; and

(d) redisplaying said image of said reference figure on said screen of said monitor for comparing said reference figure with said trace figure.

7. The method of claim 6 wherein said student-user may select said reference figure from a plurality of available reference figures.

8. The method of claim 6 further comprising the step of generating a score indicative of the comparison between said reference figure and said trace figure.

9. The method of claim 6 further comprising the step of generating an audible signal indicative of the comparison between said reference figure and said trace figure.

10. A computer system for developing drawing and/or penmanship skills of a student user, comprising:

(a) means for displaying an image of a reference figure;

(b) means for displaying an image of a trace figure as said trace figure is being created by said student-user;

(c) means for blanking out at least a portion of said displayed image of said reference figure within a predetermined time after said student-user begins to create said trace figure; and

(d) means for comparing said reference figure and said trace figure.

11. The computer system of claim 10 wherein said means for displaying said image of said reference figure includes a monitor.

12. The computer system of claim 11 wherein said monitor is capable of accepting through-the-screen data input entry by said student-user.

13. The computer system of claim 13 wherein said monitor includes a touch-sensitive screen.

14. The system of claim 10 wherein said comparing means comprises means for generating a score indicative of the comparison between said reference figure and said trace figure.

15. The system of claim 10 wherein said comparing means comprises means for generating an audible signal indicative

of the comparison between said reference figure and said trace figure.

16. A computer system for developing drawing and/or penmanship skills of a student-user, comprising:

a processor;

an input device interfaced with said processor;

an output device interfaced with said processor; and

a memory unit electronically coupled with said processor;

wherein the computer system performs the steps of:

retrieving a bit map data file stored within said memory unit;

displaying on said output device an image of a reference figure, said image of said reference figure being created from said bit map data file;

accepting from said input device a trace figure;

displaying an image of said trace figure as it is created;

blanking out on said output device at least a portion of said displayed image of said reference figure within a predetermined time after acceptance of said trace figure begins; and

redisplaying on said output device said image of said reference figure to permit a comparison of said reference figure and said trace figure.

17. The computer system of claim 16 wherein said processor comprises a graphics card.

18. The computer system of claim 16 wherein said output device comprises a monitor.

19. The computer system of claim 18 wherein said monitor is capable of accepting through-the-screen data input entry by said student-user.

20. The computer system of claim 19 wherein said monitor includes a touch-sensitive screen.

21. The computer system of claim 16 wherein the computer system also generates a score indicative of the comparison of said reference figure and said trace figure.

22. The computer system of claim 16 wherein the computer system also generates an audible signal indicative of the comparison of said reference figure and said trace figure.

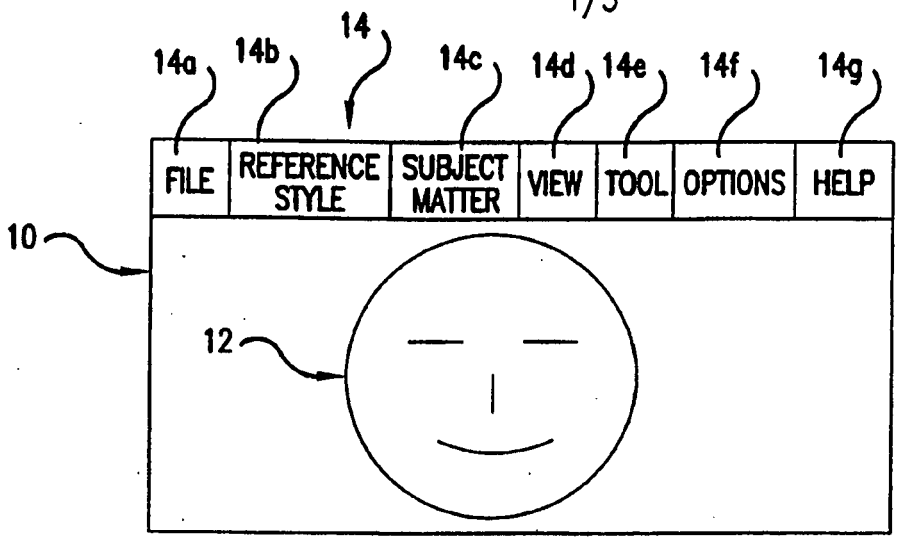

FIG.1A

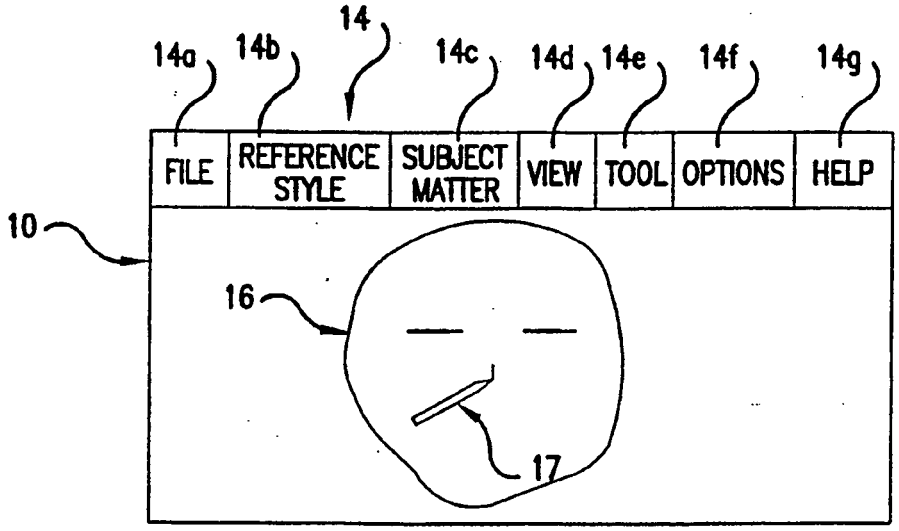

FIG.1B

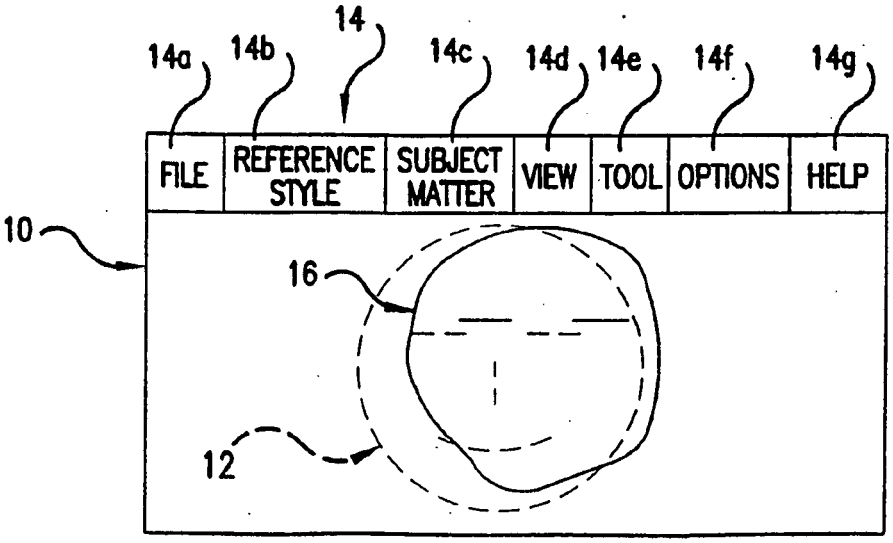

FIG.1C

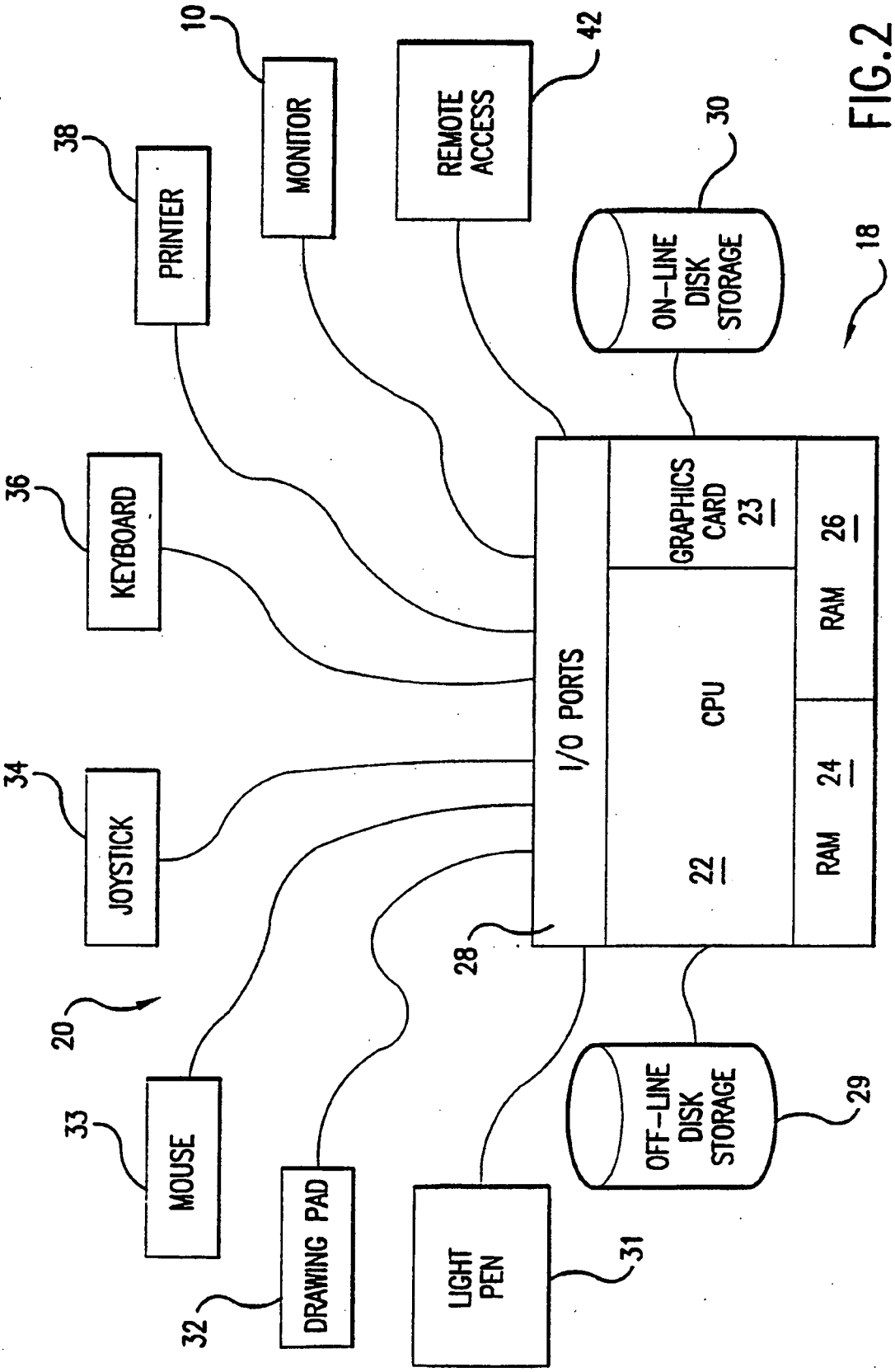
10
MONITOR
42
REMOTE ACCESS
38
PRINTER
30
ON-LINE DISK STORAGE
18
36
KEYBOARD
GRAPHICS CARD 23
26
RAM
I/O PORTS
CPU
22
34
JOYSTICK
RAM 24
28
20
33
MOUSE
OFF-LINE DISK STORAGE
29
32
DRAWING PAD
LIGHT PEN
31

FIG.2

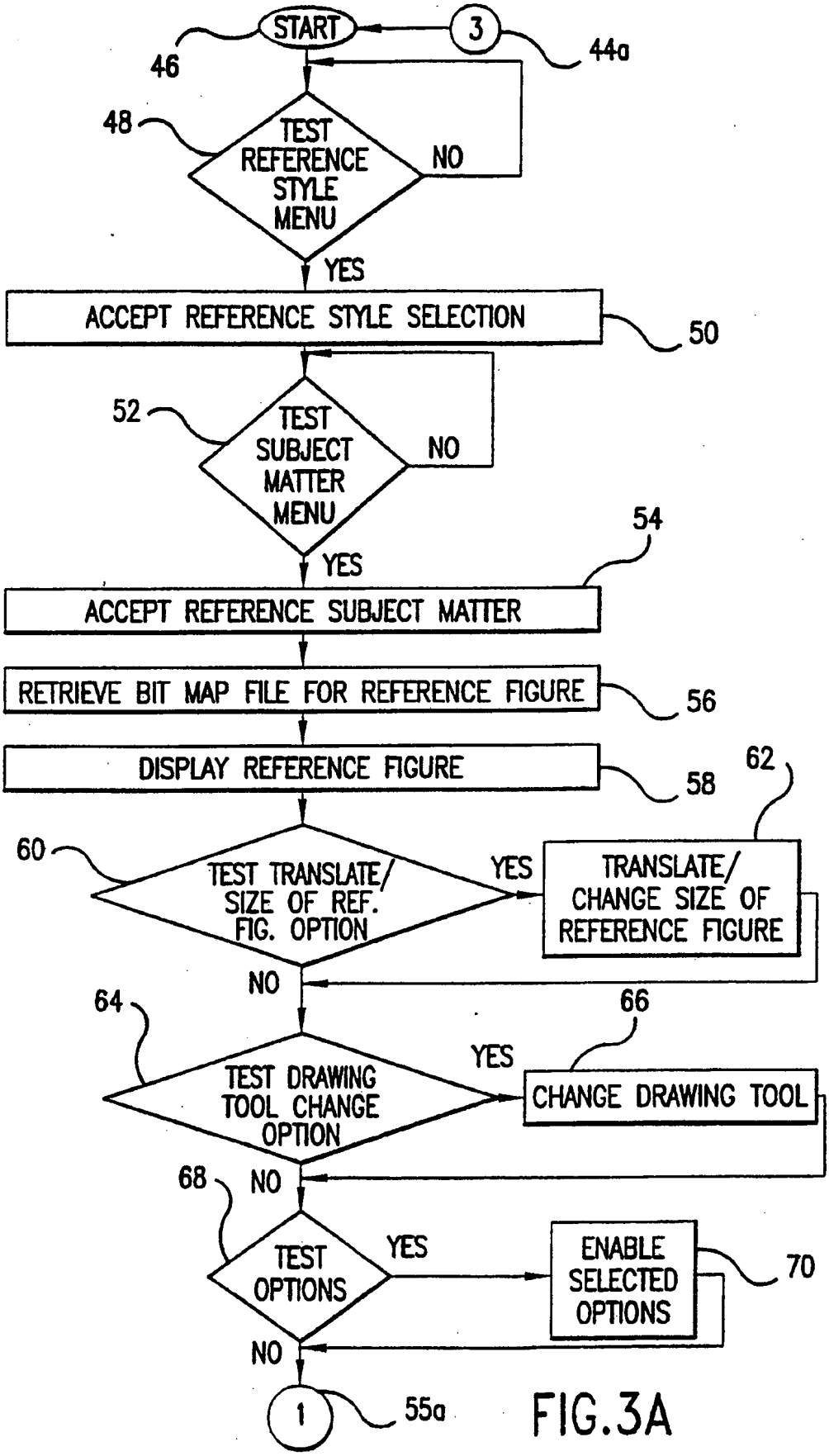
START
3
46
44a
48
TEST REFERENCE STYLE MENU
NO
YES
ACCEPT REFERENCE STYLE SELECTION
50
52
TEST SUBJECT MATTER MENU
NO
YES
54
ACCEPT REFERENCE SUBJECT MATTER
RETRIEVE BIT MAP FILE FOR REFERENCE FIGURE
56
DISPLAY REFERENCE FIGURE
58
62
60
TEST TRANSLATE/ SIZE OF REF. FIG. OPTION
YES
TRANSLATE/ CHANGE SIZE OF REFERENCE FIGURE
NO
64
66
TEST DRAWING TOOL CHANGE OPTION
YES
CHANGE DRAWING TOOL
68
NO
TEST OPTIONS
YES
ENABLE SELECTED OPTIONS
70
NO
1
55a

FIG.3A

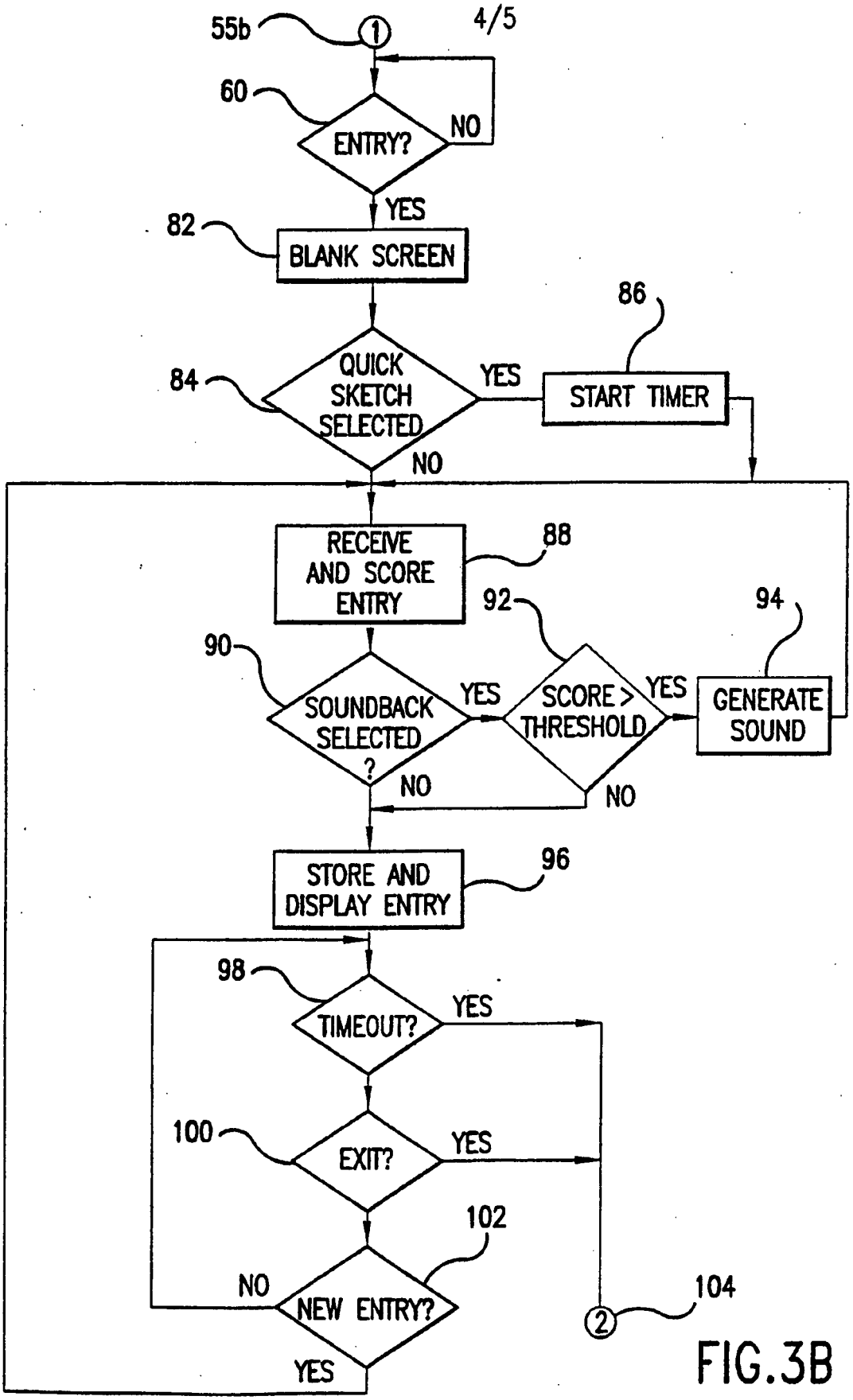
55b
1
60
ENTRY?
NO
YES
82
BLANK SCREEN
86
84
QUICK SKETCH SELECTED
YES
START TIMER
NO
RECEIVE AND SCORE ENTRY
88
92
94
90
SOUNDBACK SELECTED ?
YES
SCORE > THRESHOLD
YES
GENERATE SOUND
NO
NO
STORE AND DISPLAY ENTRY
96
98
TIMEOUT?
YES
100
EXIT?
YES
102
NO
NEW ENTRY?
YES
2
104

FIG.3B

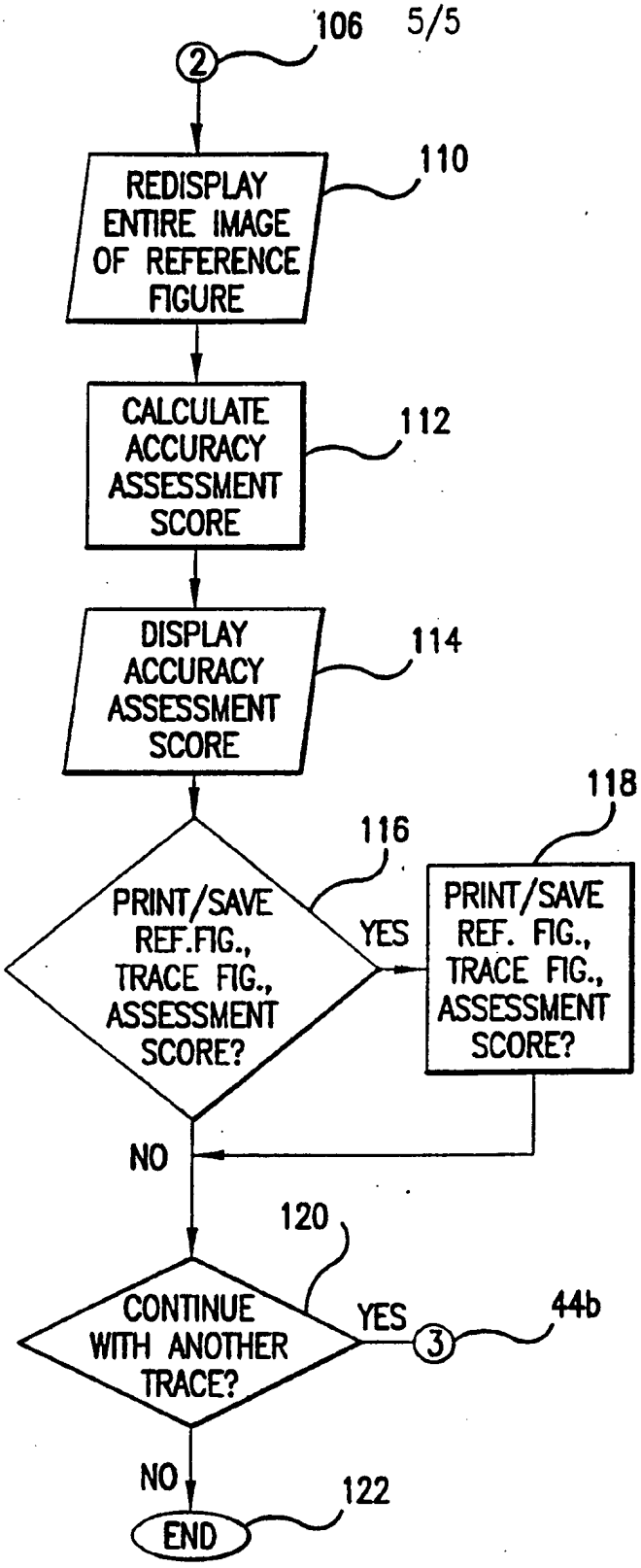
106
2
REDISPLAY ENTIRE IMAGE OF REFERENCE FIGURE
110
CALCULATE ACCURACY ASSESSMENT SCORE
112
DISPLAY ACCURACY ASSESSMENT SCORE
114
116
PRINT/SAVE REF.FIG., TRACE FIG., ASSESSMENT SCORE?
YES
118
PRINT/SAVE REF. FIG., TRACE FIG., ASSESSMENT SCORE?
NO
120
CONTINUE WITH ANOTHER TRACE?
YES
3
44b
NO
122
END

FIG.3C

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/01210

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : G08C 21/00; G09B 11/00
US CL : 345/328, 326, 327
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 345/328, 326, 327, 339, 340, 341, 342, 343, 346, 347, 348, 349, 350, 352

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

IDW, APS, EIC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,397,865 A (PARK) 14 March 1995, entire patent.	1-22
A, P	US 5,636,036 A (ASHBEY) 03 June 1997, entire patent.	1-22
A	US 5,513,991 A (REYNOLDS ET AL) 07 May 1996, entire patent.	1-22
A	US 5,208,869 A (HOLT) 04 May 1993, entire patent	1-22
A	US 4,793,810 A (BEASLEY, JR.) 27 December 1988, entire patent.	1-22
A	US 5,251,268 A (COLLEY ET AL) 05 October 1993, entire patent.	1-22

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 07 APRIL 1998	Date of mailing of the international search report 19 MAY 1998
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer STEVE SAX Telephone No. (703) 305-3800

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